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REVIEW OF L. A. SENA'S BOOK
"COLLISIONS OF ELECTRONS AND IONS WITH GAS ATOMS"

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Electrical phenomena in gases, namely gas discharges of various types, are responsible for the properties of electronic and ionic instruments extensively used in modern technology. The basic feature of these processes is the "collisions" or, to be more precise, the reaction of electrons and ions with neutral and excited atoms and molecules of gas, and also with each other. This book is therefore of interest to technicians as well as to physicists dealing with the passage of electric currents through gases and vacuum. The author, L. A. Sena, a pupil of D. A. Rozhanskiy, one of the outstanding Russian pioneers in this field, has been doing experimental and theoretical work for many years on the problems treated in the book and is a highly qualified specialist. This accounts for the book's scientific merits and up-to-date coverage.

The book is a monograph which embraces a definite series of problems, namely, those relating to the concept of the effective cross section of the atom for various reactions with electrons and ions. The book outlines the existing theories, the present state of the corresponding experimental techniques and the results of measurements; it gives a basic critique of individual theories and experiments and sets forth new viewpoints, either proposed by the author, or in which he participated to a considerable extent.

As a result of the author's concentration on problems of effective cross section, the title of the book is broader than the actual contents. The title "Effective Cross Sections of Gas Atoms During Their Collisions With Electrons and Ions" would have been more correct.

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Chapter I, "Quantitative Characteristics of Elementary Processes," gives some new definitions introduced by the author. One can, in the main, agree with these definitions and with the new classification of "collision" processes proposed by the author. It would have been better, however, if a full explanation had been given of the relationship between the new terms "direct inelastic processes" and "inverse inelastic processes" and the customary widely used terms "inelastic collisions of the first type" and "inelastic collisions of the second type." In the same chapter, as an appendage to the phenomena of the interaction of the particles, a relationship is deduced from the laws of the conservation of energy and momentum which enables one to find, after a collision, the maximum angles of deviation of the incident impinging particle from the original direction of its motion for various ratios of the masses of the interacting particles. The last paragraphs of Chapter I pose basic questions concerning the validity of the widespread simplified concepts of "free path length" and "effective cross section."

Chapter II sets forth the fundamentals of the experimental procedure for determining the effective cross section.

Chapter III explains the main elements of the technique of the experiment.

Chapter IV discusses in detail the problem of effective cross section during inelastic collisions of electrons with atoms.

Chapter V is devoted to the dispersion of an electron beam by atoms, the dependence of effective cross section and, consequently, free path length upon speed of the incident impinging electrons and "mobility" of the electrons. In regard to the latter problem, the author comes to the skeptical conclusion that it is perhaps advisable to regard the experimental data on mobility obtained from diffusion experiments and probe measurements as initial data for determining the free path length and the mean loss of energy by electrons during collisions, rather than to make any estimates of discharge phenomena working from the theory of electron mobility and from the existing data for free path length and energy losses.

Chapter VI, "Collisions of Ions and Atoms," is the longest in the book, covering 64 pages, whereas the other five chapters take up 136 pages. It contains an exposition of the problems which most closely coincide with the scientific interests of the author. In dealing with these problems, he has expressed an original point of view which has now been confirmed experimentally to a considerable extent. One such problem is the special character of the interaction of positive ions with neutral particles of gas, which also leads to the special character of the motion of the positive ions in the discharge. According to the concepts and calculations of the author, the basic process of the interaction of positive ions with neutral particles of gas is the process of overcharging, that is, the process of electron exchange between atom and ion. The probability of this process, according to the author's reckoning, is much greater than the probability of elastic collision. As a result, the ions formed in the "plasma" of gaseous discharge, during inelastic electron collisions, lose their charge before they have time to accomplish an elastic collision with a particle of gas.

During overcharging, the neutral particle is transformed into a positive ion which moves down the gradient of the charge field until the next act of overcharging. In this way the motion of positive ions in the plasma is, to a considerable degree, regulated in direction and speed. It is possible to calculate the mean velocity of ions in a discharge field. The results of such calculations are in good agreement with the experimental values for velocities of positive ions in the direction of the axis of the discharge tube and perpendicular to this direction, which recently have been optically determined.

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from the shifting of spectral lines irradiated by excited ions. It is, of course, difficult to say how far these new concepts will take us in deciphering the character of the motion of positive ions in gaseous discharge and what additions must inevitably be made to the new picture of random thermal motion, but, subject to this reservation, the step taken by the author is very important, interesting, and promises much that is new for the theory of gas discharge.

Enough has been said to permit the many merits of the book to be properly assessed. However, L. A. Sena's book is not free from faults. The first of these considerably decreases the value of the book, for in it there are still traces of servile admiration of Western science and disdain for the work of Soviet scientists. The author merits a severe rebuke because in his description of the work of the Tyndall laboratory, which determined the variations in the path of a positive ion for high field intensities, he fails to mention the work carried out in Moscow University by Balog, who showed that the path is similar in the case of negative ions. Neither is there any mention made of the work of B. N. Klyarfel'd (VEI) which is closely connected with the problem of the movement of electrons and ions in plasma (calculation of the variation in effective cross section of atoms with electron speed etc.). But especially unpardonable is the fact that, while treating the problem of the interaction of particles of gas and emphasizing the difference between close and remote interactions, not only as regards overcharging but also in other cases, the author does not once refer to A. A. Vlasov's plasma theory, which showed the vital role played by remote interactions. This theory was published as long ago as 1938 and is still being successfully developed.

One may not agree with the authors of new theories and, without leaving the ground of healthy scientific polemics, may dispute their initial positions, methods, and conclusions. One may even, in case of disagreement, limit oneself to a brief criticism a few lines long, but it is not permissible in a serious monograph which lays claim to complete coverage of a particular field, as this book does, to ignore completely the work of a Soviet scientist who has pointed out a possible new approach for solving the problem of the behavior of charged particles in plasma -- an approach which has led to clear-cut results, not only in his own later works, but also in the works of other persons (Bogolyubov in the USSR and Max Born abroad).

The book is not badly produced. Nevertheless, the author and the publishers have not succeeded in avoiding some very annoying slips of the pen or printers' errors. For example "cross section of elastic distance" is printed for "cross section of elastic dispersion" on page 172. A useful innovation is the author's use of the word "monokinetization" in connection with an electron beam instead of the somewhat far-fetched term "monochromatization".

We consider that the reader of the book under review will find much that is valuable, useful and new, but he will look in vain for a complete description of USSR work in the field. Were it not for this great drawback, it would have been possible to accept L. A. Sena's monograph as a very good book. As it is, this cannot be done.

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